United States
Department of
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**Natural
Resources
Conservation
Service**

Part 612 Water Quality
National Resource Economics Handbook

Chapter 4 Evaluation Techniques

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612.0400 Introduction

The value of changes in water quality equals the sum of the associated changes in producer surplus and consumer surplus. Calculation of changes in producer surplus is based on changes in net income. Changes in consumer surplus usually are estimated with non-market valuation models.

612.0401 Changes in net income

Producer surplus changes are sometimes described as changes in net income. Producers may experience increased or decreased net income from changes in management practices that decrease nonpoint source pollution. Frequently, their net income decreases, the new management practice is more time-consuming, or some risk is associated with the change. Otherwise, one would expect the producers to have changed their management practices already. However, sometimes producers benefit from a change in management practices. For example, animal health benefits may decrease the producer's veterinary costs.

Analysis of net income with and without the change is necessary to learn the direct effects on net income of implementing source controls. Analysis of the direct effects on risk and management time may also indicate whether producers will want to adopt the change.

612.0402 Risk

Risks are perceived differently by affected individuals and are viewed as more or less acceptable based on parameters that are not always captured in risk analyses. As part of most risk analyses, possible outcomes from a course of action are inventoried. Values are assigned to each outcome, and the probability each outcome would occur is estimated. The product of each outcome's probability with its value is calculated. The sum of the products is an expected value of the course of action. Refer to chapter 3 and chapter 7 of the U.S. Army Corps of Engineers *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning*, Volume I (Principles) and Volume II (Examples) for further details. The two volumes of this publication are available from the Natural Resources Conservation Service economists in the Northeastern States. The chapters cited describe how to implement the risk and uncertainty guidance in Principles and Guidelines, p. v, section 1.4.13 and in Supplement I to chapter 1.

Risk perceptions are influenced by more factors than the probability and severity of risk. Slovic, et al (1982) suggests the importance of other factors, especially whether the risk is voluntary or imposed, whether an outcome may be fatal, and the extent to which the risk is memorable, outside personal control, persistent over generations, and inequitably distributed. If any of these factors are present in the before or after scenarios, they will most likely influence the decision-maker's acceptance of or resistance to change.

612.0403 Methods to value non-market impacts

The change in consumer surplus resulting from a water quality improvement is determined from non-market valuation techniques (estimating values from environmental services). This handbook does not dictate a specific method to use when estimating non-market benefits. Examples of analyses are presented and can be modified to fit a particular situation.

Travel cost, Contingent Valuation, Unit Day Value, and other non-market valuation methods, such as hedonic pricing, may be appropriate to value non-market impacts. In the future, stated preference methods other than Contingent Valuation, such as the discrete choice experiments conducted for marketing research, may be applied more frequently to the valuation of non-market goods and services (see Adamowicz, Louviere and Williams 1994). The Travel Cost Method (TCM), Contingent Valuation Method (CVM), and Unit Day Values are described in section 2.8.2 of Principles and Guidelines. A more recent manual is provided by the Corps of Engineers (1986), National Economic Development Procedures Manual - Recreation. More recent developments have changed the field of non-market valuation extensively.

Several legal rulings pertain to the use of non-market valuation methods in the context of evaluating natural resource damages. Proposed guidelines are in Federal Register 15 CFR Chpt. IX (1/15/93), 15 CFR Part 990 (1/7/94), and 43 CFR Part 11 (5/4/94).

(a) Contingent valuation

The Contingent Valuation Method finds benefits by surveying people about how much they value a non-market good or environmental service in monetary terms. People are asked their willingness to pay for better environmental quality or the compensation they would require for a decline. The distribution of responses is then analyzed to determine an estimated value.

In various locations and contexts, monetary benefits of hunting, fishing, better water quality, pollution prevention and other non-market goods have been estimated from contingent valuation studies. Contingent valuation studies have also generated estimates for preventing pollutant damages. For a bibliography of contingent valuation studies, see Carson et al. (1993). Contingent valuation estimates of benefits and damages are expressed as dollar values as shown in example 4–1.

In example 4–1 the payment vehicle is pledges to a conservation fund. Under the proposed legal rules for the use of contingent valuation in natural resource damage assessments, one would not use a payment vehicle that had connotations of charity, 1) because some experts believe it is inappropriate to include money pledged for charitable motives in the value of environmental amenities, and 2) because the collection of a contribution is not viewed by respondents as certain to occur. The effects of payment vehicle were tested in the study of this example with an alternative county tax increase payment vehicle.

The ranges of value shown in the response task would bias responses to fall in the middle of the range of $1.00 to $39.00. To mitigate this problem, different versions of the questionnaire would need to be sent out with a variety of ranges shown in the contingent valuation questions. Alternatively, a questioning format other than the one shown in the example would be used to elicit payment amounts.

The proposed legal guidelines also steer researchers away from mail survey formats for contingent valuation studies. Telephone formats or combined mail and telephone formats are recommended instead of mail surveys, and in-person formats are preferred to either.

The Contingent Valuation Method may be capable of estimating non-use values, such as existence values. Observed/indirect methods, such as Travel Cost, are limited to a narrower range of applications than Contingent Valuation. In particular, the Travel Cost Method cannot be used to estimate non-use values.

Example 4–1 Using contingent valuation to value farmland protection

Dr. John C. Bergstrom, University of Georgia-Athens, directed a project to value protection of Greenville County, South Carolina, farmland (Bergstrom, Dillman, and Stoll 1985). A mail survey was sent to randomly selected Greenville County households in 1981 to 1982. The surveys elicited willingness to pay for protecting prime agricultural land. In one version of the survey instrument, respondents checked off the amounts they would be willing to contribute yearly to a conservation fund to protect all, 3/4, 1/2, and 1/4 of the prime farmland in Greenville County, e.g.:

Only 3/4 of the prime farmland in the county (54,000 acres) would be included in the protection program. Willingness to pay (yearly contribution to conservation fund)

Check or write in amount

___$1.00	___$9.00	___$17.00	___$25.00	___$33.00	
___$3.00	___$11.00	___$19.00	___$27.00	___$35.00	_____Other
___$5.00	___$13.00	___$21.00	___$29.00	___$37.00	(Write in amount)
___$7.00	___$15.00	___$23.00	___$31.00	___$39.00	

General questions about farmland activities and attitudes toward protection were elicited prior to the contingent valuation scenario. A page of information led up to the contingent valuation response task. Photographs of what the landscape looked like with and without protection were also included with the questionnaire.

The main concerns about using the Contingent Valuation Method may be subdivided into two general areas: first, whether people formulate values accurately in the context of a contingent valuation survey; and second, whether people truthfully reveal their value for a particular good or resource. Some researchers claim that if proper questionnaire construction and administration are practiced then these sources of error can be controlled (Mitchell and Carson 1989). Others prefer to use alternative valuation methods based on observable economic behavior, such as the Travel Cost Method (Hausman et al. 1992).

The Contingent Valuation Method is discussed in the Principles and Guidelines, section 2.8, appendix 2 to section VIII.

A satisfactory contingent valuation questionnaire generally takes more than a year to develop. The questionnaire is pretested extensively in focus groups and pilot studies. When responses are returned, they are coded and entered on computer (except in those cases where telephone interviewing is done in conjunction with data entry). Values are estimated from econometic models.

(b) Travel cost

The Travel Cost Method bases estimates of demand for a resource on information about the costs associated with visiting the resource. For example, the Travel Cost Method can be used to infer values for sport fishing, bird watching, or camping. The demand for these non-market goods is estimated based on observations about the number of people visiting the resource, the distance from which people travel to visit the resource, and other factors that may influence the demand curve, such as characteristics of the population and availability of substitute goods. These data generally are not readily available and must be collected from questionnaires, maps, and resource agencies. Example 4–2 shows travel cost data requirements for swimming in the Northeastern United States. An example of a travel cost model is in appendix G of the 3/86 US Army Corps of Engineers National Economic Development Procedures Manual - Recreation, IWR Report 86-R-4. An example of a study that explains and applies the Travel Cost Method to water quality valuation is given in a publication by Bockstael, McConnell, and Strand (1988).

Principles and Guidelines, part 2.8, appendix 1 of section VII, is about travel cost modeling.

(c) Unit Day Value

The Unit Day Value method estimates annual value of recreation use as the product of estimated average annual use and the value of a recreation day. This method takes values of recreation from tables in Principles and Guidelines section 2.8.3. The value for a day of recreation may be selected from a range provided by the tables; the selection is based on local prices for comparable recreation opportunities available through markets. Alternatively, a point system can be used to assign dollar values to a recreation day. The assignment of points is based on attributes of the recreation activity. The points are also given in Principles and Guidelines section 2.8.3 (table VIII-3-2).

Example 4–2 Travel cost data requirements for swimming in the Northeastern United States

As part of a larger 1989-1990 study of damages from acid rain in the Northeastern United States. A telephone screening survey asked respondents what water-related sports they had participated in during the preceding year (angling, boating, swimming). The survey also collected respondent socioeconomic data, such as age, education, race, and income. Analyses of non-responsive bias use such information.

A followup telephone survey about swimming included questions about the location of the site visited, the miles travelled by the respondent to visit the site and the time required to travel that far, whether transportation expenses were shared, reasons the respondent visited the site, amenities available at the site, ratings of water cleanliness at the site, scenery around the site, and trip expenses.

Example 4–3 illustrates a recreational benefit evaluation using the Unit Day Value method. This example shows the use of the Unit Day Value method to estimate recreation benefits from a water quality improvement. The analysis starts with identification of the impairment and discussion of linkages between practices and water quality impairment. Projected recreation with and without the project is compared, and a value estimated. This and remaining examples follow the worksheet format.

For more information, refer to Principles and Guidelines, appendix 3, section VIII, part 2.8. The Unit Day Value method is also described in appendix H of the U.S. Army Corps of Engineers National Economic Development Procedures Manual - Recreation (IWR Report 86-R-4).

Example 4–3 Unit Day Value method of estimating recreation benefits from a water quality improvement

Description of impairment	Sediment and phosphorous are entering Wildwood Lake, impairing boating, swimming, and fishing. Boating is especially impaired by sedimentation near docks, and by algae that catches in propellers. Swimming and fishing are affected by turbidity and algae growth. Historical data and baseline projections associate water quality impairments with reduced recreational use. The Wildwood Lake Association has been keeping attendance records since 1980 when conditions in the lake began to noticeably change. Recreation visits dropped from 70,000 to 65,000 per year. It is predicted that the value of cabins built on the north shore will decline if the lake continues to lose its appeal.
Cause and effect linkages	The interdisciplinary team determined that the sediment and phosphorous are the result of upstream cropland erosion. Phosphorous is transported to the lake via the sediment. Livestock operations also contribute to the phosphorous problem. In similar situations, septic systems around the lake could also be contributing nutrients to cause algae blooms.
Treatment measure(s)	The Association plans to dredge the lake areas with the greatest sedimentation. They assumed local sponsor leadership and have developed a plan to reduce future sediment loads.
Non-market benefits	Without the plan, recreation visitor days are predicted to decrease from the existing 65,000 to 40,000 in 25 years (a loss of 1,000 visitor-days each year). With the plan, the recreation visits are predicted to increase from 65,000 to 75,000 visitor-days over 5 years and to stay constant at 75,000 visitor-days thereafter. This 10,000 visitor-day increase is expected to result from improved water quality. Figure 4–1 shows the projected visits without and with the project. Value of a Visitor Day: Tables VIII-3-1 through VIII-3-3 in Principles and Guidelines are used to determine the Unit Day Value for a given project. The interdisciplinary team for Wildwood Lake determined that the current Unit Day Value is $6.10. With improved water quality as a result of the project, the Unit Day Value is expected to increase to $6.30 within the first year and remain constant thereafter.

Example 4–3 Unit Day Value method of estimating recreation benefits from a water quality improvement—continued

The benefits for recreation would be calculated as follows:

Value of future recreation without project

A decrease of 25,000 (65,000 – 40,000) visitor days over 25 years would average 1,000 days per year x 179.0653 (the present value of a decreasing annuity, 25 years, 8% interest) x $ 6.10 per day x .09368 (the 25 year amortization rate at 8%) = $102,326 average annual value. Adding the value of the 40,000 recreation day base, 40,000 x $6.10 = $244,000. The total future without project average annual value would be $102,326 + 244,000 = $346,326.

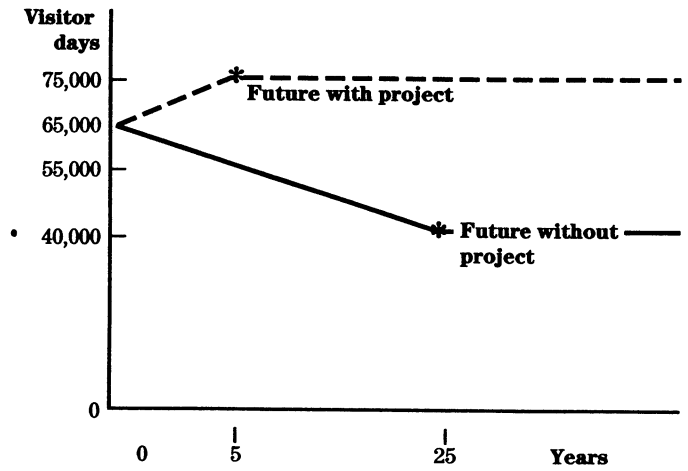
Value of future recreation with project

An increase of 10,000 (75,000 – 65,000) visitor days over a 5-year period would average 2,000 days per year x 11.36514 (the PV of an increasing annuity, 5 years, 8% interest) x $6.30 per day x .09368 (the amortization for 25 years at 8%) = $ 13,515 average annual value. Add the value of the 65,000 recreation day base = 65,000 x $6.30 = $409,500. The total with project average annual value would be $409,500 + $13,515 = $423,015.

Summary of benefits

Recreation values with and without the project are compared. The total average annual recreation benefits would be $423,015 – $346,326 = $76,689. The costs of the dredging and sediment control measures would be subtracted from the National Economic Development account. The monetary value of the annual recreation benefits are added to the National Economic Development account. The environmental effects, measured in physical terms, are shown in the Environmental Quality account.

Figure 4–1 Projected visits



(d) Hedonic pricing

Hedonic pricing is a method for calculating the demand for environmental services or some other non-marketed characteristic based on observed purchases of a marketed good. Price differentials in the marketed good are linked to differences in levels of environmental service and in levels of other characteristics. Like travel cost analysis, hedonic pricing is classified as an observed/indirect method for finding the value of an environmental service. The two most common applications of hedonic pricing use differentials in property values and in wages to infer demand for non-marketed characteristics.

Property values often already reflect many water quality values. Changes in property values can be an acceptable method for estimating the values of onsite and offsite water quality improvements. A qualified appraiser estimates property values with and without the project.

If property value appraisals are used, one must ensure that all the physical changes expected to occur with and without the project must be accurately described to the appraiser. Follow the procedures for establishing real estate values described in the draft of the Economics Handbook chapter, Land Easements and Right-of-Way. Maintenance of property values is described in Principles and Guidelines section 2.3.3(g).

Example 4–4 uses the change in property values method to estimate aesthetic damages to a lake from nutrients delivered by crop erosion. The Unit Day Value (UDV) method was used to evaluate the same water quality project in example 4–3. The impairment identification and cause-effect relationships are the same as before.

Hedonic pricing reflects benefits of improved recreation and aesthetics to private property owners. If recreation benefit estimates are available from an alternate method (Travel Cost, Contingent Valuation or Unit Day Value), adding the values together results in some benefits being counted twice. For example, the value in example 4–4 of $44,415 cannot be added to the UDV estimated recreation benefit of $76,689 determined in example 4–3. The value to the property owners for their lake recreation activities would be double-counted. The recreation benefits estimated to be attributable to property owners need to be subtracted from the sum to avoid double-counting.

In the rare event that benefits estimates are available both from a hedonic pricing study and from an alternate method, the economist would add the two estimates, but subtract recreation benefits accruing to property owners from the total. The corrected sum is reported in the NED account.

(e) Transferability from other studies

Often a previous valuation study will have been done for a similar resource problem. University professors, the EPA, professional journals, such as the Journal of Environmental Economics and Management, and State fish and game or environmental protection agencies are helpful for locating prior valuation studies. See also the Carson et al (1993) bibliography. If a previous valuation study has been done, its similarity and overall quality should be evaluated.

Differences between the resource(s) valued in the study or studies and the resource of interest should be identified. Dollar values should be normalized to constant dollars for a base year. Other factors that need to be examined would be differences in tourism rates, area population, and changes in the site itself from the previous time of study. If the site being evaluated was not previously studied, then differences between it and the site of the previous study should be carefully documented.

Example 4–4 The property value hedonic pricing method for estimating the benefits of water quality improvements

Quantify non-market benefits

Real estate agents and county appraisal records were used to determine that lakeside property values were 10 percent higher than these in surrounding areas under existing conditions. There were 27 homes located on the northern shore of the lake. The current average value of these homes is $50,000. The value of similar houses on a lake with deteriorated quality was estimated to be 10 percent lower (or $45,000). Wildwood lake would deteriorate to such conditions in 25 years.

The future without project average annual property values would be: $50,000 present value minus the $45,000 value at year 25 = $5,000 over 25 years, or an average of $200 decline per year x 179.06530 (the PV of a decreasing annuity, 25 years, 8% interest) x .09368 (the amortization rate for 25 years, 8% interest) equals $3,355 average annual value per house. Adding this to the $45,000 without project value of the home at year 25 yields $48,355. Multiplying this $48,355 by the 27 houses yields the average annual value of the lake property, $1,305,585.

The future with project average annual property values would be:

$50,000 x 27, or $1,350,000 average annual value

Summarize net benefits

The average annual project benefits for maintaining property values would be:

$1,350,000–$1,305,585 = $44,415

The average annual benefits of $44,415 would be reported in the National Economic Development account.